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Art. V.—*Notes on Australian and New Zealand Foraminifera. No. 2: The Genus Pavonina and its Relationships.*

By WALTER J. PARR, F.R.M.S.

(With Plate VII.)

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Introduction.

Of the several species of *Pavonina* described, only one, the genotype, *P. flabelliformis* d'Orbigny, has been recorded from the Indo-Pacific region. It is confined to this area, and is there widely distributed, but is seldom common. The few Australian records are, as a Recent form, from off Raine Island, Torres Strait, 155 fms. (Brady), 16 miles east of Wollongong, N.S.W., 100 fms. (Jensen), and shore sand, Lord Howe Island (Heron-Allen and Earland), and, as a fossil, from the Miocene of Victoria at Batesford (Heron-Allen and Earland), and the Lower Beds at Muddy Creek, near Hamilton (Howchin; Heron-Allen and Earland). It is not known from New Zealand.

During the last few years, in the course of the examination of washings from the Tertiary of Victoria, the writer has met with examples of the genus at several localities. Two species occur. One of these is *P. flabelliformis*, while the other is a new species, described below under the name of *P. triformis*, which has previously been confused with *P. flabelliformis*. It differs from previously described species of *Pavonina* in having a triserial stage preceding the series of alternating chambers, and resembles the genus *Reussia* in its early development. *P. triformis* is confined to the Oligocene and Miocene, while *P. flabelliformis* occurs only in the Lower Pliocene and Post-tertiary. From the study of the two species, including excellent Recent examples of *P. flabelliformis*, it appears that *P. triformis* is the progenitor of *P. flabelliformis*, and that *Pavonina* should be placed in the Buliminidae, near the genera *Reussia* and *Chrysalidinella*.

Description of the Species.

Genus **Pavonina** d'Orbigny, 1826.

Pavonina flabelliformis d'Orbigny.

(Plate VII, figs. 4, 5.)

Pavonina flabelliformis d'Orbigny, 1826, p. 260, pl. x, figs. 10, 11; Modèles, No. 56. Brady, 1879, p. 282, pl. viii, figs. 29, 30; 1884, p. 374, pl. xlv, figs. 17, 19-22 (*non* 18). Chapman, 1902, p. 231. Jensen, 1905, p. 812. Heron-Allen and Earland, 1915, p. 632, pl. xlviii, figs. 1-6; 1924a, p. 619. Cushman, 1926, p. 20, pl. vi, figs. 1-4. (*non* Howchin, 1889, p. 7. Heron-Allen and Earland, 1924b, p. 141.)

The records of this species show it to be confined to the warmer areas of the Indo-Pacific region, usually in shallow water, although Cushman had it from the exceptional depth of 1033 fathoms, near Midway Island, in the North Pacific. Chapman's notes on the occurrence of *P. flabelliformis* at Cocos Keeling Atoll indicate that it is most at home in the quiet waters of the coral lagoon. Brady had the species from as far north as the coast of Korea, while the most southerly record is that by Jensen from 16 miles east of Wollongong, N.S.W., 100 fms. The West Indian form recorded by Brady as *P. flabelliformis* is not that species, and has been described by Cushman under the name of *P. atlantica* (*vide* Cushman, 1926, where the genus is revised).

Two of the three Victorian fossil examples are from the Lower Pliocene (Kalimnan) of the Hamilton district, an exceptionally fine one, which is figured, being from Forsyth's, on the Grange Burn, while the other is from the clays overlying the red limestone, opposite Henty's, also on the Grange Burn. The third specimen is a small, imperfect one from the Post-tertiary of a Victorian Geological Survey bore at Boneo, near Rosebud, 177-187 feet. These appear to constitute the only records of *P. flabelliformis* as a fossil, since previous records, from the Miocene of Victoria, relate to *P. triformis*.

In the published descriptions of *P. flabelliformis*, no reference seems to have been made to the trifacial compression of the early portion of the test in many specimens, although it appears to be present in two of the examples figured (Figs. 3 and 4) by Heron-Allen and Earland in their Kerimba Archipelago monograph (*op. supra cit.*). The example here figured from Forsyth's exhibits this feature, and it is exceptionally well displayed in another from Cocos Keeling Atoll, for which I am indebted to my friend, Mr. Frederick Chapman. The latter specimen begins with a very small, trihedral stage, the margins of the angles being limbate and the lateral faces depressed, with an ornament of short, longitudinal costae (Fig. 5). So far it resembles *P. triformis*, but it is not possible, without sectioning the specimen, to determine whether the chambers following the proloculum are arranged biserially or triserially. However, the resemblance between the two species in their early stages is so striking that there can be little doubt as to their close relationship, especially when one considers also their geological history and distribution.

Pavonina triformis, sp. nov.

(Plate VII, figs 1, 2a-c, 3a, b.)

Pavonina flabelliformis Howchin (*non* d'Orbigny), 1889, p. 7. Heron-Allen and Earland, 1924b, p. 141, pl. viii, fig. 22.

Description.—Test many chambered, in side view roughly triangular in the early stages, later becoming sub-flabellate, about as wide as long, early portion of the test trihedral, with the angles limbate and sharp, the earliest chambers triserial, followed by a

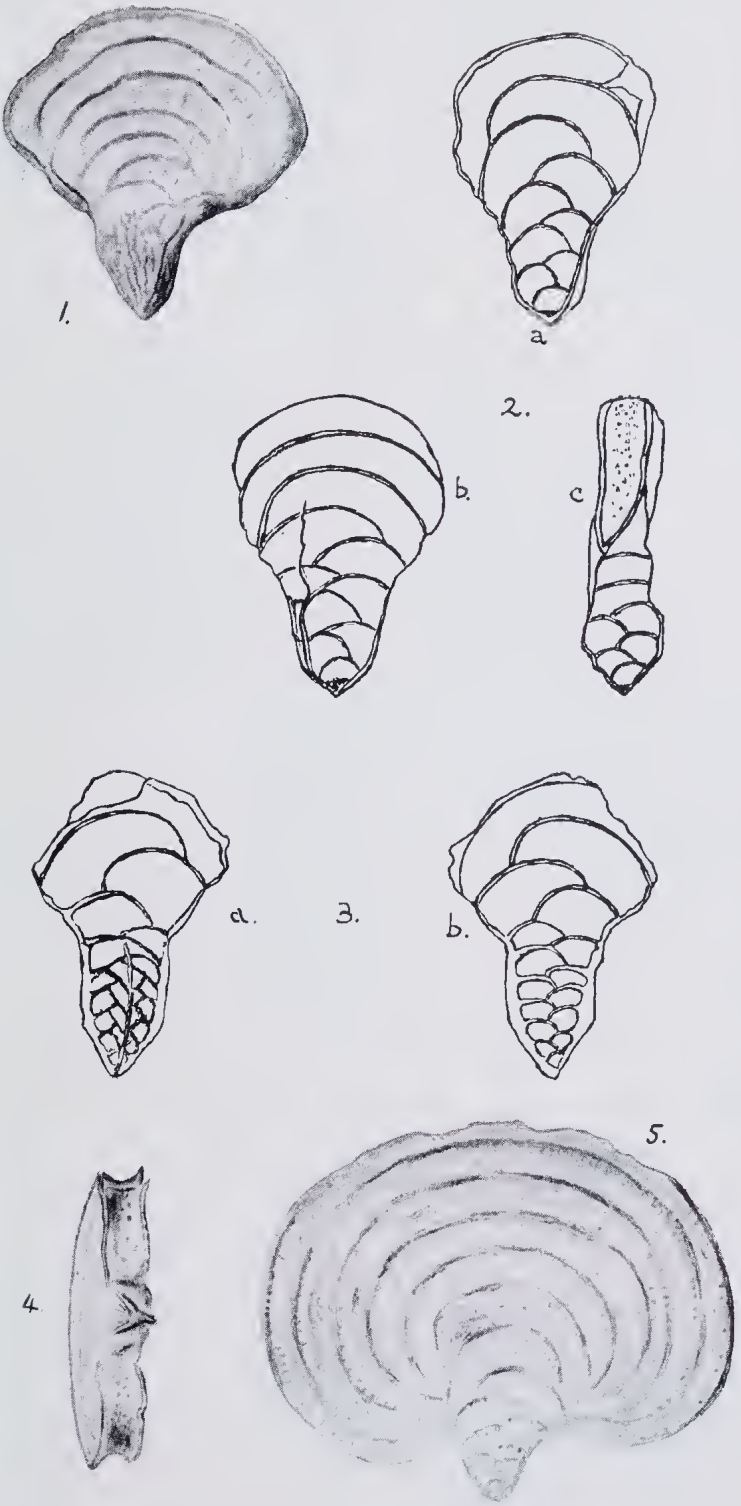
series of chambers arranged alternately, adult chambers curved and spreading, but never more than semi-annular, uniserial; sutures limbate, depressed, distinct; wall usually thin and coarsely punctate, except that of the early portion of the test, which is thickened and ornamented by longitudinal costae and beads; these sometimes cover the whole test, when they become weaker as they approach the periphery; apertures a series of coarse perforations in the depressed peripheral face.

Diameter up to 0·7 mm.

Holotype (Parr Coll.) from Miocene, marl bed in polyzoal limestone, base of cliffs, N. end of bathing beach, Torquay, Vic.

Remarks.—About forty examples of this interesting species were found. They include both megalospheric and microspheric forms, the latter being distinguished by the greater length of the trihedral portion of the test, as well as by the larger number of triserial chambers. The triserial stage, in the specimens examined in glycerine, consists of from one to four sets of chambers. Fig. 3 represents a microspheric example with twelve chambers in the triserial portion. This will illustrate very clearly the close relationship the present species bears to the genus *Reussia*. As it appears that *P. flabelliformis* is a derivative of *P. triformis*, it follows that the genus *Pavonina* should be placed in the Buliminidae, near the genera *Reussia* and *Chrysalidinella*. Dr. J. A. Cushman, in his recent, epoch-making classification of the foraminifera, places *Pavonina* in the Heterohelicidae, because of the traces of planospiral coiling in the very early stages in the microspheric form. This is a feature of *P. mexicana*, described by Dr. Cushman from the Lower Oligocene (Alazan) of Mexico (Cushman, 1926, p. 22, pl. vi, figs. 7-9), but it is not clear from his generic description whether it has been observed in all of the species placed in the genus. As it is not present in *P. triformis*, two conclusions suggest themselves. Either the coiling does not occur in *P. flabelliformis*, in which case there can be no doubt as to the relationship of the two Indo-Pacific species and the consequent placing of the genus in the Buliminidae. It would then follow as a matter of course that *P. mexicana* and perhaps *P. americana* should be transferred to another genus. On the other hand, if the planospiral coiling has been observed in *P. flabelliformis*, the relationship to *P. triformis* would be extremely doubtful, and probably a new genus would need to be created for the reception of the latter species. The evidence already given is in favour of the close relationship of the two Indo-Pacific species, and the shell wall and ornament characters of them both are also more typical of the Buliminidae than of the Heterohelicidae.

Occurrence.—Oligocene: Altona Bay Coal Shaft. Miocene: Marl bed in polyzoal limestone, N. end of bathing beach, base of cliffs, Torquay; Marl overlying limestone, Filter Quarry, Batesford; Lower Beds, Muddy Creek, near Hamilton.



W.J.P. ad nat. del.

Figs. 1, 2a–c, 3a, b.—**Pavonina triformis.**
Figs. 4, 5.—**Pavonina flabelliformis.**